NOT FOR PUBLICATION UNTIL RELEASED BY THE
HOUSE ARMED SERVICES COMMITTEE
TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES SUBCOMMITTEE

STATEMENT OF
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BEFORE THE
TERRORISM, UNCONVENTIONAL THREATS AND CAPABILITIES SUBCOMMITTEE
OF THE
HOUSE ARMED SERVICES COMMITTEE
ON
THE FISCAL YEAR 2010 BUDGET REQUEST

MAY 20, 2009

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Introduction

It is an honor to appear before you to report on Science and Technology (S&T) efforts within the Department of the Navy and discuss how the President's FY 2010 Budget Request supports the Navy and Marine Corps.

The Naval S&T challenge is to support a Navy and Marine Corps capable of prevailing in any threat environment. In recent months, ONR has engaged in a direct, unprecedented, hands-on partnership with the Chief of Naval Operations and the Commandant of the Marine Corps. We are unanimous in thinking that in order to address critical challenges facing the Navy and Marine Corps of today and tomorrow, the Office of Naval Research (ONR) must: 1) focus on S&T areas that provide the biggest payoff for the future, 2) be innovative in our thinking and business processes, and 3) improve our ability to transition S&T to acquisition programs. The President's FY 2010 Budget requests $1.8 billion in the Naval S&T portfolio to accomplish these goals.

S&T Strategic Plan

Earlier this year, an updated Naval Science and Technology Strategic Plan was approved by Navy and Marine Corps leadership. It reaffirms alignment of Naval S&T with current Naval missions and future capability needs – and continues to ensure S&T has long-term focus, meets near-term requirements, and makes our course clear to decision makers, S&T partners, customers and performers. The Strategic Plan identifies 13 key areas where S&T investment will have high payoff in supporting Navy and Marine Corp requirements. Those areas are:

Naval S&T Strategy Focus Areas

- **Power & Energy**
- **Maritime Domain Awareness**
- **Operational Environments**
- **Asymmetric and Irregular Warfare**
- **Information Superiority & Communication**
- **Power Projection**
- **Assure Access and Hold at Risk**
- **Distributed Operations**
- **Naval Warfighter Performance**
- **Survivability and Self-Defense**
- **Platform Mobility**
- **Fleet/Force Sustainment**
- **Total Ownership Costs**

Executing the Strategy

We execute Basic Research (6.1) thru Advanced Technology Development (6.3) funds by dividing S&T into three areas – Discovery and Invention (D&I), Innovative Naval Prototypes (INP), and Future Naval Capabilities (FNC).

Discovery & Invention

Discovery and Invention (D&I) is basic research (6.1) and early applied research (6.2) in areas where we have unique requirements or support capabilities essential to the naval mission. Investment in these areas is necessary to ensure we maintain technical advantages for our Naval forces. D&I develops fundamental knowledge, provides the basis for future Navy/Marine Corps systems, and sustains the Defense Scientist and Engineer workforce.

Approximately 40% of our S&T investment is in D&I. This reflects our desire, as well as that of congress and the President, to maintain a robust investment in basic and early applied research. We rigorously assess impact on Navy/Marine Corps missions and potential for innovative performance in order to invest those resources in the best research areas and projects. This builds the foundation of our S&T portfolio by developing a broad base of scientific knowledge from which INP, FNC, and quick reaction efforts are generated. Approximately 60% of basic research is executed with academic and non-profit performers.

In 2008, motivated by growing concerns that maintaining the status quo represented a significant risk to national security, Secretary Gates initiated a DoD-wide increase in basic research funding. These funds enhanced our ability to maintain technical advantages relative to global innovation in areas such as the science of autonomy, information assurance, information fusion and decision sciences, energy and power management, and social/cultural modeling.

Also in 2008, an external panel of university, industry, and DoD experts continued their review of our entire D&I portfolio, to assess research performance with respect to S&T quality, program plan, and Naval impact. The panel evaluated overall portfolio direction, whether there were promising research areas in which we had not invested, and opportunities for collaboration with other organizations and agencies. The panel reaffirmed overall performance as strong; while encouraging expanded collaboration. We plan to continue external peer review of our D&I investments, annually reviewing approximately one third of the portfolio.

An important component of D&I is the Defense University Research Instrumentation Program (DURIP), designed to support university research infrastructure essential to high quality Navy research. This instrumentation program complements other Navy D&I programs by supporting the purchase of high cost research instrumentation necessary to carry out cutting-edge research. ONR awarded 68 grants for this purpose in FY 2007, 92 in FY 2008, and 82 in FY 2009.

Another D&I component is ONR's Basic Research Challenge Program, designed to stimulate interdisciplinary research investments in high-risk emerging scientific and technical fields. In 2009, ONR selected the following research topics: 1) Irreducible Uncertainty and the Limits of Predictability in Ocean-Atmosphere Modeling, 2) Elastomeric Polymer-by-Design to Protect the

Warfighter against Traumatic Brain Injury by Diverting the Blast Induced Shock Waves from the Head, and 3) DNA-based Molecular-scale Nanoelectronics Fabrication.

One of the largest contributions made through D&I investments is development and sustainment of the S&T workforce. Through the Independent Laboratory In-house Research (ILIR) and Independent Applied Research (IAR) programs, ONR sponsors cutting edge research and furthers the education of scientists and engineers at our Warfare Centers. We provide education and research opportunities to undergraduate and graduate students, fellows, future faculty members and researchers. This is achieved through specific programs, such as the Naval Research Enterprise Internship Program (NREIP), which expose students and researchers to work done at Naval laboratories, as well as other research opportunities.

Through the University Research Initiative (URI) and Young Investigators Program (YIP), ONR gains access to researchers with an understanding of, and willingness to investigate high priority topics of interest to the Navy that intersect multiple technical disciplines.

In addition to supporting external research, ONR supports internal research within the Navy's corporate laboratory, the Naval Research Laboratory (NRL). This support, known as the NRL base program, develops S&T to meet the needs identified in the Naval S&T Strategic Plan and nurtures the world class skills and innovation that exist within our in-house laboratory.

In addition, we support Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) with education and research partnerships. Through a variety of demonstration, apprentice, award, and graduate programs, we encourage young men and women to consider and explore S&T careers in academia, the Naval labs, and industry.

Innovative Naval Prototypes

Innovative Naval Prototypes (INP) represent approximately 10% of the S&T budget. They focus on high risk, high payoff, game changing opportunities emerging from the D&I portfolio that can significantly impact naval capabilities if we can mature the technology.

INP efforts are often discontinuous, disruptive, radical departures from established requirements and operational concepts. As such, they are approved and overseen by the Naval S&T Corporate Board consisting of the Assistant Secretary of the Navy (RD&A), Assistant Commandant of the Marine Corps and Vice Chief of Naval Operations. The goal is to prove the concepts and mature the technology within 4-8 years, allowing informed decisions about reductions in technological risk to govern transition into an acquisition program.

We have met major milestones in all four current INPs:

We have developed and tested a more powerful lab gun in our Electromagnetic Rail Gun INP. Within twelve months, our Electromagnetic Rail Gun program has doubled current state of the art muzzle energy. Additionally, the program has a series of technical objectives scheduled this year to validate progress towards completion of Phase I in FY 2011.

The Tactical Satellite (TacSat) INP will be completed in FY 2010. Four satellite payloads have been delivered for launch. Ocean Data Telemetry Microsatellite Link payloads were integrated on TacSats 3 and 4, with the Comm-X communications package as the primary payload on TacSat 4. Most technology, and some personnel, transitions to the Operationally Responsive Space program office in New Mexico.

In August 2008, the Persistent Littoral Undersea Surveillance (PLUS) INP conducted a major Autonomous Underwater Vehicle (AUV) trial off the coast of Hawaii with thirteen unmanned undersea vehicles, powered and gliding, working collaboratively to demonstrate autonomous sensing and onboard processing of undersea targets.

In the Sea Base Enablers INP, last year's CNR testimony reported selection of three concepts for further design and model testing. In 2008, we completed a set of multi-ship tests to characterize relative motions between vessels, evaluate ramp excursions, quantify forces and structural loads, and correlate results with computer predictions and analytical models. Results were provided to each of the three contract design teams for incorporation into their technology development.

Additionally, we plan to establish two new INP programs in FY 2010:

The Free Electron Laser (FEL) INP will enable the Navy to fight at the speed of light by bringing high power laser technology to sea for ship defense. This project will develop a laser for use in the maritime environment, consistent with Navy plans for an all-electric ship. The FEL provides intense beams of laser light tuned to atmosphere-penetrating wavelengths, allowing us to assess the potential of laser-based shipboard defense strategies.

The Integrated Topside INP will provide Navy with the ability to dominate the electromagnetic spectrum through the development of multifunction apertures for all classes of ships. Over and above development of highly flexible, multi-beam, multi-function apertures, we are developing: 1) open architecture for Radio Frequency (RF) equipment, in addition to computer hardware and software that will enable multiple industries to contribute to development of affordable new systems and upgrades, and 2) modular systems that enable the same technology to be scalable across all Naval platforms to significantly reduce logistics, training, and maintenance costs.

Future Naval Capabilities (FNCs)

Our Future Naval Capability (FNC) program is the most critical component of our transition strategy. FNC investments were restructured in 2005 to better align this "requirements-driven, transition-oriented" portion of the S&T portfolio to Naval Capability Gaps identified by OPNAV and Marine Corps Combat Development Command (MCCDC).

As opposed to high-risk/high-payoff INP projects, FNCs involve near-term projects. FNCs are included in the portion of our budget focusing on Acquisition Enablers (approximately 30% of our overall budget). The FNC process delivers mature technologies to acquisition sponsors for timely incorporation into systems and products that deliver new capabilities to the warfighter.

FNCs are based on earlier D&I investments, where technology has matured to the point that it can achieve a Technology Readiness Level (TRL) of 6 or better within 3-5 years. FNC projects are selected annually to address specific capability gap needs, with final prioritization approved by a 3-Star Technology Oversight Group (TOG) representing OPNAV/USMC, U.S. Fleet Forces Command (USFF), Assistant Secretary of the Navy (ASN-RDA) and ONR.

All approved technology products are required to have Technology Transition Agreements that document the commitment of the resource sponsor, acquisition program, and ONR to develop, deliver and integrate products into new or upgraded systems that can be delivered to the Fleet/Force. Every FNC product's progress and transition status is reviewed annually. Products that no longer have viable transition paths are terminated with residual funding used to solve unexpected problems with existing projects, or start new projects in compliance with Navy priorities.

There are 158 FNC projects in various stages of their 3-5 year development. Nineteen are expected to complete in 2009 and transition in 2009/10. The FY 2010 budget request continues funding for remaining projects and initiates an additional 23.

FY 2009/10 transitions include: automated battle management aids for ballistic and cruise missile defense, a low cost imaging seeker that provides terminal guidance for weapons directed at moving targets, an expeditionary vehicle obstacle avoidance system to mitigate threats from improvised explosive devices (IEDs), and electromagnetic armor that improves survivability and mobility of combat vehicles.

We plan to complete 21 additional projects in FY 2010 to transition in 2010 /11. They include: swimmer detection/targeting capability that helps defend harbor and near-shore infrastructure against asymmetric threats, weapon fuse improvements for standoff assault breaching of mines buried in shallow water and surf zones, the capability to perform precision navigation and mark assault lanes in mined environments, and a closed loop ventilation system for casualties that can be used in the evacuation process.

The critical measure of FNC success is whether our projects meet technology requirements and exit criteria, and whether acquisition sponsors have transition funds in their programs to accept and integrate FNC products. Products with planned transition funds usually transition after risks are mitigated, a definitive plan is finalized, and required funding is programmed. As shown in the table below, we have had good success in this effort. We expect equally strong performance in 2009.

FNC Transition Summary	FY05		FY06		FY07		FY08	
	# Products	% Plan	# Products	% Plan	# Products	% Plan	# Products	% Plan
Products Planned to Complete	30		26		35		32	
S&T Completed or near complete with Manageable Risk	28	93%	25	96%	35	100%	32	100%
S&T Completed or Near Complete and Transition Funds Programmed	20	71%	24	92%	27	77%	20	63%
S&T Completed or Near Complete and Transition Funds Planned	4	14%	0	0%	5	14%	10	31%
S&T Completed and No Transition Funding	4	14%	1	4%	3	9%	2	6%

Increases and Decreases in FNC Funding Levels

FNC investments focus on the most pressing capability gaps identified each year. This generates year-to-year movement in funding levels for associated Program Elements (PEs). As FNC investments mature and develop technology products over a 3-5 year period, the Technology Readiness Level (TRL) of underlying products moves from 6.2 to 6.3 PEs. The first year is predominantly 6.2; the final year is predominantly 6.3 – with a mix of 6.2/6.3 in-between. As products deliver and transition to Advanced Component Development and Prototypes (6.4) and Engineering and Manufacturing Development (6.5) funding, new FNC products do not necessarily start in the same PEs as those completed. Although resulting changes may appear to be program growth, they actually reflect realignment of funds in response to successful technology transition – coupled with reprioritization and start of new efforts based on evolving Naval needs and requirements.

Current S&T Program Highlights

The Naval S&T portfolio includes a range of projects either entering the fleet or poised to do so in a short time. I include examples of these efforts with respect to the direct impact they will have on Sailors and Marines, both today and in the future.

Manpower, Personnel, Training and Education

In FY 2010, ONR's Capable Manpower FNC is focused on developing innovative, technology-based products to support Navy/Marine Corps Human Capital programs. These include human systems integration, manpower, personnel, and training products that provide new approaches to selection, classification, training, distribution, assignment, and job performance to ensure future combatants and sea-service components are staffed for optimal readiness.

Force Utilization Through Unit Readiness and Efficiency (FUTURE) and Personnel Integration of Selection, Classification, Evaluations and Surveys (PISCES) programs blend behavioral research and economic theory in a virtual experimental environment. These programs, combined with an integrated Total Force career span assessment system, will help deliver products, tools, and information enabling attainment of goals outlined in Navy's *Strategy for Our People 2016*. Additionally, PISCES will expand and incorporate assessments of knowledge, skills, abilities, and personality to improve person-to-job fit.

A program to develop and demonstrate validated, effective, adaptive training system components to enhance individual and team training for submarine navigation and piloting skills will be extended to training for personnel manning surface ship combat information centers.

A Human Systems Integration program is underway to enable advanced design methods and tools supporting rapid, spiral, human-centered design processes to support the total life cycle of complex naval systems. Further, Capable Manpower is studying methods to improve officer and crew situational awareness in increasingly stressed tactical and strategic operations, as well as developing information architecture to improve decision making in submarine attack centers.

Infantry Immersion Trainer

The Infantry Immersion Trainer (IIT) is a revolutionary training system that prepares Marines and Sailors for deployment to today's battlefield environment. The facility uses virtual reality, physical structures, holograms, pyrotechnics, and live role players – simulating a Southwest Asian village in the midst of combat – to give troops necessary skills to win and survive in battle. Equipped with laser-tag-like weaponry, Marines, Navy Corpsmen, and Army soldiers, walk through realistic dwellings and alleys – including sounds and smells – encountering civilians and enemy combatants. The IIT confronts warfighters with a range of possible scenarios requiring split-second decisions and action. High-tech simulation provides a safe, yet realistic, training environment for learning how to prevent fatal errors before being exposed to real threats.

IIT software-based systems allow for rapid improvement of training delivery, and the simulated scenarios can be tailored to suit mission or individual needs. Repeatable and scaleable scenarios increase skills in less time. The first IIT facility opened in 2007 at Camp Pendleton; a second is planned to open at Camp Lejeune in 2009. The IIT system incorporates ONR technologies, DARPA initiatives in game-based simulators, as well as technologies sponsored by the Army Research Development and Engineering Command's Institute for Creative Technologies at the University of Southern California.

Marines in Operational Environments

When the Commandant of the Marine Corps visited ONR in August, 2008, he made clear that while the "Marine Corps has recently proven itself in sustained operations ashore, future operational environments will place a premium on agile expeditionary forces, able to act with unprecedented speed and versatility in austere conditions against a wide range of adversaries."

Marines must be two-fisted fighters – able to destroy enemy formations with scalable air-ground-logistics teams in major contingencies, and equally able to employ superior Irregular Warfare (IW) skills honed in on-going conflicts. ONR has taken the lead in rebalancing traditional and IW capabilities by providing quantifiable technical advantages to warfighters in Afghanistan and Iraq. While IW favors indirect, asymmetric approaches, it may employ the full range of military and other capabilities, in order to erode an adversary's power, influence, and will.

In implementing *Marine Corps Vision and Strategy 2025*, Marine Air-Ground Task Forces (MAGTF) of the future, either from the sea or in sustained operations ashore, must be leaner in equipment. ONR initiatives will help reduce the load of dismounted Marines and Sailors through new materials and technologies that are much lighter, while providing enhanced protection in combat.

Persistent intelligence, surveillance and reconnaissance technology will provide tactically relevant information in all phases of a broad spectrum of operations. It will enhance situational awareness and understanding – enabling real-time decision making that provides proactive, predictive capabilities for Asymmetric and IW, as well as traditional encounters.

The use of unmanned aerial cargo vehicles to rapidly move logistics on a distributed battlefield and complete casualty evacuation, as well as revolutionary robotics to enhance ground logistics delivery, are future capabilities equally applicable to IW and traditional warfare.

ONR has been in front of efforts to improve survivability for the Marine Corps current and future family of tactical vehicles. Efforts to develop optimized fiber composite materials, amenable to advanced high volume fabrication techniques, and active protection systems for vehicles against rocket propelled grenades and missiles help make Marine Corps forces more agile, lethal, mobile and survivable.

Large Scale S&T Demonstrations for Protection of Ground Forces and Systems

Major integrated technology demonstrations will investigate dramatic new capabilities in the Protection of Ground Forces and Systems. The demonstrations are wide ranging, encompassing technologies for pre-detonation of Improvised Explosive Devices (IEDs), personal protection materials, personal power generation, micro power sources, and augmented reality.

The integrated demonstration program will be a broad, multi-year effort to both investigate technology integration, as well as spur application of more fundamental technologies for force and platform protection. The integration of safer ways to remotely detonate IEDs will require additional power – while technologies to enhance the protection capacity of equipment that mitigates effects of blast, blunt trauma, ballistic and directed energy attacks on individuals will require new materials and nanomaterials.

Additional sources of advanced power systems for dismounted Marines/Sailors will be embedded in the demonstrations. Power systems include advanced batteries, fuel cells, and personal power. Augmented reality will demonstrate fusion of organic and individual borne sensors with existing datasets to provide enhanced decision systems and situational awareness. These demonstrations will result in multiple broad phased force protection applications and technologies – with immediate utilization of all fielding successes.

Operational Adaptation

Operational Adaptation (OA) is intended to identify, develop, and demonstrate S&T solutions for future conflict. These conflicts, sometimes called “hybrid complex warfare” or “hybrid complex operations” may include any or all elements of conventional, irregular, disruptive, or catastrophic threats. Recognizing that adversaries are adaptive, rather than try to predict the exact threat and counter that prediction, OA provides warfighters with capabilities to develop and sustain a tempo of adaptation and decision-making that is superior to any adversary's ability to match. OA anticipates fighting on turf that favors the enemy and is intended to help warfighters orient rapidly, become pro-active earlier, and dominate adversaries with increasing effectiveness.

Unlike large-scale mechanized formations in the industrial age, today’s adversaries try to hide by submersing themselves within complex environments. OA includes the ability to understand "human terrain" – to distinguish between adversarial/non-adversarial populations. Affordable, scalable, persistent surveillance is vital to OA. Our forces have capability gaps in maintaining

surveillance over large areas with the persistence and resolution needed to identify threat activity and provide timely indications and warnings. These gaps are caused by limits of current sensor technologies, and by manpower requirements associated with operating individual systems and data interpretation. Several ONR projects are directed towards overcoming these limitations.

Utilization of improved sensors necessitates understanding the resulting data. Where mechanized warfare required understanding the physical characteristics of weapons platforms and their employment, hybrid warfare requires that we understand human phenomena. ONR utilizes the social sciences to investigate solutions to problems in human, social, cultural and behavioral arenas. These solutions will help develop a better understanding of "human terrain" phenomenology, apply that phenomenology in operational contexts, and design or modify technologies that will enable us to make better use of affordable, persistent surveillance products.

We are not just studying the problem. ONR has an aggressive program to demonstrate results to operators, get feedback, work out the bugs, and transition successful technologies to the field. This capability will also exploit automated system cues for human intervention as appropriate.

During FY 2010, ONR will conduct an Integrated Technology Demonstration to address operational gaps that preclude adequate warning of non-conventional hostile activities through affordable, autonomous, persistent, pervasive littoral surveillance. Success metrics associated with this demonstration include achieving sufficient advanced warning of hostile intent and actions to enable our forces to respond at the time and place of our choosing – rather than awaiting an enemy attack and then reacting to it.

Improvised Explosive Devices (IEDs)

Working with the Joint IED Defeat Organization (JIEDDO), ONR funds research efforts aimed at attacking IED networks and devices, and enhancing training for our forces. In conjunction with other agencies, ONR is investing in prediction efforts involving terrorist activity associated with bio-forensic profiling to trace place of origin, factory location, support networks, placement, and dynamic analysis of suicide bombing. These projects anticipate future threats, and put us in a better position to respond to changing conditions.

Sponsored by D&I investments, scientists at Columbia, Drexel, University of Miami, and other organizations working in ONR's Automated Image Understanding (AIU) program developed computational methods and algorithms for recognizing hundreds of object categories and human activities including tracking and analysis of human behavior. The intent is to develop an automated means for identifying people and behavior to highlight potentially threatening situations as they emerge. AIU is a critical capability for many DoD missions including, situational awareness, persistent and adaptive surveillance, and autonomous operations.

Detection efforts are geared towards enhancing our ability to achieve persistent surveillance of battlespace – understanding, identifying, and locating signatures associated with manufacture, transport, and placement of IEDs. Near-term initiatives include the Advanced Technology Development efforts to neutralize IEDs through improved countermeasures as well as locating

and directly attacking the device. Long-term S&T includes bio-inspired sensing systems for detection and tracking of explosive components in ports, coastal, and ocean environments.

It is important to remember that IEDs are mines. ONR's advances in countering IEDs are 100% compatible with Countermine Warfare in any environment. Threats posed by IEDs and mines are one of the reasons ONR is developing technologies to separate warfighters from hazardous missions, while providing increased economy of force. Efforts are underway to develop novel man/machine interfaces to enhance crew capability and situational awareness – with the ultimate goal of developing unmanned, autonomous systems to displace the operator from the battlespace.

Medical Research related to IEDs and Hearing Loss Prevention

ONR continues work with the medical community to better understand the effects of IEDs and develop tools to connect event and medical data. Force Health Protection Advanced Technology Development efforts include modeling human responses to blast, ballistic, and blunt trauma, as well as modeling physical and cognitive effects of blast exposure and conditions arising from traumatic brain injury.

Another area of emphasis is reducing hearing damage to personnel in high noise environments. We are working with medical and acquisition communities exploring multiple approaches to reduce noise, attenuate noise that still exists, monitor and assess exposure, develop advanced personal protective equipment, and develop enhanced warnings and procedures to ensure exposure does not become damaging. A suite of technologies developed under the FNC program are now transitioning to the warfighter as part of the acquisition sponsor's Flight Deck Cranial program of record. We are working on treatment, including ground-breaking pharmaceutical interventions for situations where potentially damaging exposure does occur.

Naval Undersea Medical Research

Undersea Medical Research is a National Naval Responsibility. ONR is regarded as a world leader in the field, with investments to: 1) further our understanding of health threats to undersea warfighters, 2) develop novel mitigation strategies for decompression sickness, arterial gas embolism, and oxygen toxicity for disabled submariners and divers, and 3) assess other health challenges associated with undersea deployment. Products from our Undersea Medicine Program, such as the development of non-recompression strategies for the mitigation of decompression illnesses, the elucidation of biological mechanisms that govern oxygen toxicity, and understanding the epidemiological consequences of undersea deployment will improve efficiency, flexibility, and safety of manned undersea operations.

Vertical Lift

In recognition of the important role of rotorcraft in current and projected combat operations, humanitarian relief, and other missions, ONR continues to invest in vertical lift technology. The current program includes research into enabling technologies and new concept vehicle systems for automated resupply of distributed Marine Corps and Navy ground forces, and options for a future Joint Multi-Role aircraft.

Technologies of particular interest and in development are durable composite structures and modeling of ship/air wake interactions, including air vehicle dynamic interfaces. Investments to enable future high speed vertical lift aircraft are being leveraged through partnership with the Army and Defense Advance Research Projects Agency (DARPA) in the Joint Heavy Lift (JHL) program. Ship compatibility attributes of a potential future JHL are being investigated.

ONR continues its commitment to the rotorcraft community by partnering with the Army in applied research investment via the National Rotorcraft Technology Center (NRTC). These investments not only show benefits from the synergy of collaborative planning and execution, but are cost shared by the Center for Rotorcraft Innovation, an industry-academia consortium.

Our long-term vision for Vertical Take Off and Landing (VTOL) aircraft combines improved mission effectiveness, increased affordability, maintainability, reliability, and unprecedented levels of aircrew safety and survivability. To achieve these breakthroughs we will join with the Army in the Vertical Lift Research Center of Excellence, with participation from Navy labs, NASA, and innovative performers from academia.

Power Projection and Time Critical Strike

Revolutionary Approach To Time Critical Long Range Strike (RATTLRS) is a Navy, Air Force, NASA, and OSD interagency cooperative program, to develop a high speed non-afterburning turbine, Mach 3 flight demonstration program for a future expendable high speed strike weapon. The most significant challenge facing this high risk program is mitigating unanticipated vibration encountered during turbine engine tests.

The Long Range Anti-Ship Missile (LRASM) is a joint Navy/DARPA demonstration program that will significantly advance anti-ship missile technology by demonstrating survivability while penetrating advanced air defense networks – and achieve robust lethality through precision targeting. A LRASM flight test is expected in FY 2012.

Affordable Platforms

Cutting edge technologies are of little value if unaffordable. Affordability factors and cost reduction technologies are embedded throughout the S&T portfolio. ONR efforts such as the Navy Manufacturing Technology (ManTech) Program and the Enterprise and Platform Enablers FNC contribute to affordability in acquisition programs and throughout the lifecycle of systems and platforms. This includes using operations research, modeling and simulation, and computer sciences to reduce costs and improve the caliber of training and skill maintenance technologies. Affordability technologies are being developed for a wide variety of new sensors including biosensors with chemical/biological utility, Anti-Submarine Warfare sensors, and persistent surveillance sensors being developed as part of ONR's Operational Adaptation initiative.

The CNO's directive on affordability and cost-cutting in shipbuilding led to a major restructuring of the Navy ManTech portfolio in 2006. This reemphasis led ManTech to focus on shipbuilding solutions that cut acquisition costs. Currently, ManTech continues to focus on technologies that

reduce costs of processing and fabrication for composites, electronics and metals, shipbuilding and repair technology, and technical engineering support for DDG 1000, CVN 21, Littoral Combat Ship, and VIRGINIA Class Submarines.

Among ongoing cost reduction efforts, ONR is developing ultra reliable materials and sensors that incorporate condition-based, zero maintenance capabilities. This includes research into the development and manufacture of durable alloys, thermal barrier coatings, ceramic matrix composites, and other promising materials. These could provide major cost savings in areas such as maintenance of ship topside surfaces, high performance airfield pavements, and a variety of motors and turbine engines. We are also researching airframe and ship anti-corrosion technologies, as well as technologies allowing non-destructive examination and inspection.

Future Power Systems

ONR continues to invest in advanced technologies for high efficiency electrical systems and equipment to meet increasing electric power requirements for advanced weapons, launchers and defensive systems aboard ships and submarines. Our S&T focus is on technologies and system architectures that increase power and energy densities and efficiency. These efforts directly support NAVSEA's Electric Ship Office *Next Generation Integrated Power Systems Roadmap*, and the Navy energy strategy to reduce the amount of fossil fuel used by our fleet.

In concert with the Defense Department and Navy Task Force Energy focus on energy security and reducing the amount of fossil fuel used by our forces, we continue to invest in the Naval Future Fuels effort investigating the impact of new fuel formulations on Naval machinery. In FY 2009, congress added $20M for Alternative Energy Research. We are using this funding to evaluate energy positive structures, advanced solar and wind technologies, ocean thermal technologies, and to address the system integration impacts of intermittent, renewable alternative energy sources on power grids. Finally, ONR continues to support research in fuel cells, methane hydrates, and other alternative sources of energy.

Automated Image Analysis

In the 1980s, ONR initiated research in the mathematical and computational foundations for processing, analysis, and understanding of imagery/video. ONR's basic research resulted in the development of wavelet-based compression algorithms that became the industry standard. More significantly, Navy put ONR-developed compression algorithms on the F/A-18 video pod. ONR is further developing a mathematically rigorous framework for automating image analysis. One example is partial-differential-equation (PDE) based image registration and enhancement tools. The resulting image analysis and exploitation tools have been used to support operations in Iraq. This effort continues with a focus on automatically understanding entities/activities in imagery and video to address information overload, a problem which must be solved if we are to be able to have responsive persistent, pervasive surveillance of the battlespace. Industry began adopting PDE-based tools in 2000 for enhancement and detection of abnormalities in medical images.

Modular Open System Architecture

Modular and open system architecture enables the Navy to affordably procure and integrate complex systems. By assembling similar components to provide a range of cost/capability trade-offs, modular system architecture can be used across all classes of ships. Open architecture enables affordable upgrades for introducing new technical advances to respond to new threats.

An example is the multi-function Electronic Warfare-Electronic Sensing (EW-ES) system ONR delivered to Program Executive Office – Integrated Warfare Systems (PEO-IWS). The system met operational requirements with scalable, open system architecture. The contract required the use of open interfaces and determined capability as a function of the number of receiver elements and channels. In addition, a third party provided components for some system elements. This allowed the PEO to not only use results of the S&T program for DDG-1000, but use underlying subsystems to develop the scaled back-fit for all ships in the Navy requiring EW-ES capability.

Similarly, the Affordable Common Radar Architecture program developed an architecture for all future radars in which the system is divided into frequency independent subsystems (radar control processor, human-machine interface, digital signal processor, digital beam-forming subsystems) which only need be developed once. They can then be used for all radars regardless of frequency and frequency dependent subsystems. The decomposition of radar into independent subsystems with open, well-defined interfaces enables Navy to procure the best components from any company and affordably upgrade only those elements which are necessary.

This experience led ONR to bring together a team of all major system integrators, along with key acquisition components, to develop Naval Radio Frequency (RF) modular system open architecture for the Integrated Topside INP. This will enable Navy to use modular construction to procure RF communications, moderate to low power radar, and electronic warfare capability across all ships with common RF hardware. This will reduce developmental acquisition, training and maintenance costs, and enable affordable upgrades due to open architecture.

This approach clearly involves acquisition challenges since various RF capabilities are currently funded by different Navy resource sponsors and acquired by different PEOs. In addition, the open subsystem construct may face Testing and Evaluation requirement challenges when only some subsystems are upgraded. I believe we can successfully address these challenges.

Marine Mammals and the Environment

Significant S&T efforts are dedicated to effective and responsible stewardship of the marine environment, and this includes the impact of national security requirements and activities on fish and marine mammals. Navy is the worldwide leader in marine-mammal research, with ONR spending approximately $14 million annually to understand how marine mammals may be affected by sound. Navy investments represent a majority of funding spent on this research in the U.S., and nearly half spent worldwide.

As previously reported, the Navy collaborates with universities, institutes, industry, conservation agencies, and independent researchers around the world to better understand what combinations

of ocean conditions, geography, and sonar usage could potentially impact marine mammals and the environment. Congress has been generous in support of these programs and I look forward to continued partnership in achieving the goal of better protecting the marine environment.

As we testified last year, we used capabilities of Marine Mammal Monitoring on Ranges at the Atlantic Undersea Test and Evaluation Center (AUTEC) in our Behavioral Response Study. The second phase of our Behavioral Response Study last summer gained new information on beaked whale responses to sonar signals and other environmental sounds. Suction cup affixed tags allowed us to follow the animals' change in foraging and swimming response. Another phase is planned for this summer in the Mediterranean Sea. We have also begun to establish a passive acoustic monitoring network around the perimeter of the Hawaiian island of Kauai to monitor humpback, sperm, and other whale migrations as they approach naval training ranges.

Lastly, our Marine Mammal Veterinary Health S&T effort directly supports Navy's Fleet Marine Mammal Systems activity, in turn providing critical support for perimeter defense, platform and swimmer protection missions. Through identification of marine mammal specific-pathogens, development of improved diagnostic tests for infections, toxin exposure and other causes of disease, and strategies for bolstering immune responses, our program is not only helping Navy animals but will facilitate National Oceanographic and Atmospheric Administration (NOAA) health assessment surveys of marine mammal populations.

Understanding the Sea

As we operate in-on-above the ocean, understanding and prediction of the marine environment, as a coupled system of atmosphere and ocean, is critical for Naval operations. Our research has concentrated on currents, acoustic properties, and storms in the Western Pacific. We are completing a study of the Kurishiro Current using a small fleet of undersea gliders continuously cycled into the current's flow for the past eighteen months. Our studies are finding new sources of acoustic variability and incorporating them into prediction systems. Last summer, we completed a study of how typhoons create deep, cool wakes in their paths that affect upper ocean acoustic properties. In addition, a decade of S&T in ocean modeling came to fruition as a new hybrid coordinate model became operational at the Naval Oceanographic Office.

Highly capable research vessels are critical to the success of our basic and applied programs in ocean sciences. Since 1972, ONR has partnered with the National Science Foundation and other agencies in the University National Oceanographic Laboratory System (UNOLS) to allow joint scheduling and operations of a fleet of research ships used by academic oceanographers. The partnership continues with procurement of the next generation of Ocean Class research vessels. Last year's budget funded a Phase I award for the Functional Design by the Program Executive Office (PEO) Ships. Phase I design studies are being completed, and a request for proposals to support competitive selection of operating institutions for the ships is about to be issued. Plans call for two ships to be built starting in FY 2011 and FY 2012, with lead ship delivery in FY 2014.

Conclusion

Thank you for the opportunity to discuss Naval S&T. The FY 2010 President's Budget request is about prevailing in today's threat environment and building a strong, flexible Naval force in the future. Building that force requires careful S&T investments to protect the nation and our warfighters. To achieve that goal, we continue moving toward greater integration of capabilities, more effective partnership between research and acquisition, and a clearer vision of how to achieve shared goals with DARPA, Army, Air Force, and other DoD research organizations.

We must monitor, assess and leverage emerging S&T in a global environment. The worldwide movement of technology and innovation demands that we be able to take advantage of emerging ideas and science wherever they originate, and we have an aggressive worldwide presence to ensure we do that. Our S&T partnerships in 70 countries, 50 states, with 900 companies, 3,300 Principal Investigators, 3,000 grad students, and 1,000 academic and non-profit entities puts us in good stead to maintain our technological edge. ONR Global offices in London, Tokyo, Singapore and Santiago, Chile help us stay on the scene and abreast of emerging S&T trends around the world.

We continue to focus the majority of our investment on external performers – those outside the Naval R&D system - in order to tap into the full spectrum of innovative thinking and discovery. Nevertheless, we need to nurture the world class skills and innovation that exist within our lab system, especially at the Naval Research Laboratory (NRL). Congressional authorization and direction to move ONR into the Lab Demo personnel system provides welcome assistance in our ceaseless effort to attract world-class scientists to become part of our organization. ONR has published its first internal business plan, establishing internal organizational goals aimed at aligning our efforts with the S&T Strategy and guiding needed organizational improvements.

For all of these reasons, I believe the state of our S&T investments is sound, represents careful stewardship of taxpayer dollars, and will significantly enhance the safety and performance of our warfighters as they serve in defense of the United States, today and in the future. Thank you for your support.